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PROVISIONAL SPECIFICATION

Invention Title:

Pressure compensating valve

The invention is described in the following statement:

Field of the Invention

The present invention relates to a pressure compensating valve and more particularly to such a valve which is of the balanced type which compensates for variations in supply pressure.

Background Art

Pressure compensating values, or regulators as they are also known, are widely used in the supply of gases and liquids from a high pressure supply to a low pressure user. It is often desirable to maintain the low pressure side of the valve at a substantially constant pressure irrespective of pressure fluctuations on the high pressure side of the valve. Balanced pressure compensating valves are known for this purpose.

Existing balanced pressure compensating valves are relatively expensive, complex and difficult to manufacture and service. The present invention directed to a pressure compensating valve which can, at least in preferred embodiments, be made in a very simple form at low cost and with good performance characteristics.

Disclosure of the Invention

The present invention consists in a pressure compensating valve comprising:

a) a first member defining a fluid inlet path;

b) a second member movable relative to the first member;

c) a fluid containing chamber defined by flexible barrier means disposed between the first and second members;

d) an inlet path for fluid to pass into the chamber; and

e) an outlet path for fluid to pass out of the chamber, the flexible barrier means including at least one flexible arcuate wall between the first and second members, the wall, in some relative positions of the first and the second members, overlies a surface of one of the members occluding an aperture therein which forms part of the outlet path and upon relative movement between those members to another relative position the flexible arcuate wall is moved by that relative movement to a position in which it does not occlude the aperture in the outlet path.

In use one side of one of the members and one side of the flexible barrier means is exposed to the outlet path while the other side of that member and the other side of the flexible barrier means is exposed to a reference pressure which may be atmospheric pressure or some other

selected pressure. In this way the second member will be moved, relative to the first member, to open or occlude the outlet path. When the pressure in the outlet path exceeds a predetermined relationship with the reference pressure the member exposed to that pressure will be moved towards the reference pressure side of the valve causing the arcuate wall of the barrier means to be rolled over, and occlude, the aperture. Conversely when the pressure in the outlet path drops below that relationship that member will move in the opposite direction and the aperture will be opened.

In its simplest form the valve acts as a one way pressure compensated valve controlling the inflow of high pressure fluid through the valve to a user, whether a human or a mechanical device. In a preferred embodiment the valve may act to control both inflow and outflow of a fluid. In this embodiment the second member is provided with at least one further aperture. The at least one further aperture is designed to be occluded by contact between the flexible barrier means and one of the members when the pressure in the outlet path is lower than the defined relationship with the reference pressure and to be open to allow communications between the outlet path and a surrounding environment when the pressure in the outlet path is higher than that defined relationship.

The flexible barrier means may comprise any one of a number of forms each of which includes a flexible arcuate wall between the first and second members. This arcuate wall curves about an axis that is preferably parallel to adjacent surfaces of the first and second members. In one embodiment of the invention the barrier means comprises a pair of membranes in spaced apart array, one on each side of the chamber. In another arrangement the barrier means may be generally U-shaped with both ends of the barrier means connected to one of the members. In a third alternative the barrier means may be a tube positioned between the first and second members.

In preferred embodiments of the invention the area of the flexible barrier means exposed to the chamber on each of its sides is equal so that any change in pressure in the inlet path will not cause the second member to be moved by differential force on opposed sides of the barrier. In other embodiments it may be desirable to deliberately utilise different exposed areas for the sides of the barrier means to bias the second member towards one position or the other. This will unbalance the compensating valve,

however, in some circumstances this may be acceptable or even desirable. A spring or other biasing means is preferably provided to bias the second member. relative to the first member, with a defined force into an open position. In this arrangement the valve will be biased into an open position by the spring until the pressure in the outlet path exceeds that of the surrounding atmosphere by an amount that causes a force to be applied to the one side of the second member to move it, against the spring force, to the closed position.

In particularly preferred embodiments of the invention the first member is annular. In this arrangement the second member is disposed within the lumen of the annular first member. The first and second members are preferably associated with an annular member of U-shaped cross section forming the flexible barrier means. For ease of manufacture it is preferred that the annular first and second members and the annular barrier means are essentially circular.

The first and second members may be conveniently formed by injection moulding of a synthetic plastics material and the barriers may be formed of a suitably flexible rubber or synthetic plastics material. As the valve may be made from only four pieces in preferred embodiments and from relatively cheap materials it can be seen that valves according to such embodiments of the present invention may offer significant advantages over conventional pressure compensating valves.

Valves according to the present invention are particularly useful in positive air pressure breathing apparatus. Such apparatus may be supplied by air pumped by means of a fan through a suitable filter. Alternatively the breathing apparatus may be of self-contained type for use either underwater or where filtering of the ambient air is inappropriate.

When a pressure compensating valve according to the present invention is used in positive air pressure breathing apparatus it may control only the inhalation of air by the user or both inhalation and exhalation. In the former case the breathing apparatus will need to incorporate a conventional exhaust valve of some sort.

Brief Description of the Drawings

Hereinafter given by way of example only are preferred embodiments of the present invention described with reference to the accompanying drawings in which:-

Fig. 1 shows a vertical section through a pressure compensating valve according to the present invention in association with an independent exhaust valve;

Fig. 2 shows a vertical section through a pressure compensating valve according to another embodiment of the present invention acting as both an inlet valve and an exhaust valve;

Fig. 3 shows a vertical section through another embodiment of pressure compensating valve according to the present invention acting as both an inlet valve and an exhaust valve;

Fig. 4 shows a vertical section through still another embodiment of the present invention acting both as an inlet valve and as an exhaust valve;

Fig. 5 shows a vertical section through a further embodiment of the present invention acting both as an inlet valve and as an exhaust valve;

Fig. 6 shows a vertical section through a fan driven positive air pressure breathing apparatus incorporating the pressure compensating valve of Fig. 5;

Fig. 7 shows a vertical sectional view through a positive air breathing apparatus supplied with high pressure air and incorporating a conventional regulator and the pressure compensating valve of Fig. 5; and

Fig. 8 shows a vertical sectional view through a positive air pressure breathing apparatus supplied with high pressure air and incorporating a different regulator and the pressure compensating valve of Fig. 5.

Fig. 9 is a schematic view showing a pressure compensating valve according to this invention incorporating a tubular barrier means positioned between a pair of planar members.

Preferred Embodiment of the Invention

Fig. 1 illustrates a pressure compensating valve 10 according to this invention in three different states;

Fig. 1(a) shows the valve 10 in an open state;

Fig. 1(b) shows both the valve 10 and an associated but separate exhaust valve 11 both closed; and

Fig. 1(c) shows the valve 10 closed but the exhaust valve 11 open.

The pressure compensating valve 10 comprises an injection moulded synthetic plastics housing 12 of circular form. The housing 12 includes a spigot 13 for connection to an air supply. The spigot 13 communicates with an annular duct 14 forming a path for the flow of air into the valve. A

radially inner wall of the housing 12 is provided with a slot 13 extending around the full inside radius of the housing 12.

A pair of flexible annular diaphragms 16 and 17 bound the slot 13 in the housing 12 and extend radially inwardly therefrom. At their radially inner edges the diaphragms 16 and 17 are connected to a cup-shaped movable member 18 formed of an injection moulded plastics material. The diaphragms 16 and 17 together with the housing 12 and the movable member 18 define a chamber 19 for the distribution of air through the valve 10.

The diaphragms 16 and 17 are each in cross-section of U-shaped configuration with the arms of the U lying against either the housing 12 or movable member 18. The base of each U-shaped diaphragms 16 and 17 spans the gap between the housing 12 and the movable member 18 and forms the sidewalls of the chamber 19.

The movable member 18 has a circular base 21 and a generally cylindrical sidewall 22. The movable member 18 can move axially of the valve housing 12 towards and away from a valve discharge space leading to exhaust valve 11. A spring 23 biases the movable member 18 towards the exhaust valve 11.

An annular recess 24 in the sidewall 22 communicates with the chamber 19 and leads air to the radially inner side of a cylindrical flange 25 connected to and coaxial with the sidewall 22. The flange 25 is provided with a plurality of spaced apart apertures 26.

The exhaust valve 11 comprises a flexible circular diaphragm 27 connected at its periphery to the housing 12. Radially inwardly of its connection to the housing 12 the diaphragm 27, when in a relaxed condition, abuts against a circular shoulder 28 on the housing 12. An inlet flap valve 29 is provided in the diaphragm 27 within the area bounded by the shoulder 28.

In use air under substantially greater than atmospheric pressure is supplied through spigot 13 into the duct 14. This air will initially find the valve 10 in the condition shown in Fig. 1(a) due to the force of spring 23 biasing the movable member 18 towards the exhaust valve 11 and thus opening valve 10. The air will thus flow in the direction shown by arrows A through the chamber 19, the apertures 26, and the flap valve 29 into a mask space 31. This flow will be repeated each time a user inhales.

When the user stops inhaling and the pressure within the mask space 31 rises just sufficiently to balance the force of spring 23 the valve 10 will

move to the condition shown in Fig. 1(b). In this condition flap valve 29 is closed and the movable member 18 is forced by the air pressure between it and the user to move away from the exhaust valve 11 sufficiently for diaphragm 16 to occlude the holes 26.

As the user starts to exhale the pressure in mask space 31 rises. This causes the diaphragm 27 of exhaust valve 11 to move away from the shoulder 28. Air can then flow past the shoulder 28 and exhaust through exhaust ports 32 as shown by arrows B in Fig. 1(c).

The arrangements of the pressure compensating valves 10 in the remaining figures is essentially similar to that described with reference to Fig. 1. The operation of the valves 10 is also essentially similar to that described with reference to Fig. 1. Similar numeric indicators will be given to similar parts in the valves 10 described with reference to Figs. 2 to 8. The construction and operation of these valves 10 will only be described to the extent that it differs from that described with reference to Fig. 1.

The valve 10 shown in Figs. 2(a), (b) and (c) differs in three major respects from that described with reference to Fig. 1. Firstly the apertures 26 are formed in the diaphragm 16 rather than in the movable member 18. Secondly the valve 10 incorporates its own exhaust valve as will be hereinafter described. Thirdly, the diaphragms 16 and 17 are joined at their radially inner ends and are connected to movable member 18 along a single line contact.

The movable member 18 is formed with apertures 33 around the periphery of the cylindrical wall 22 adjacent its base 21. These apertures 33 are overlain, and occluded by, the diaphragm 17 until the pressure in the mask space 31 overcomes the force of spring 23. The movable member 18 is then forced outwardly sufficiently to uncover apertures 26. Air then exhausts from the mask space 31 as shown by arrows B.

The arrangement shown in Fig. 3 is a combination of the inlet valve arrangement of Fig. 1 and the outlet arrangement of Fig. 2.

The arrangement shown in Fig. 4 is similar to that described with reference to Fig. 2. In this case, the diaphragms 16 and 17 are joined together and are formed with an annular flange 34. This flange 34 connects the diaphragms 16 and 17 to the movable member 18. The flange 34 is connected part way up the side of the diaphragm 17 and extends between the diaphragms 16 and 17 and the movable member 18. The flange 34 thus

serves to occlude the apertures 26 in diaphragm 16 in the situations shown in Figs. 4(b) and (c). It also serves to occlude the apertures 33 in the situation shown in Figs. 4(a) and (b). This arrangement in which the inlet and exhaust apertures lie in the same plane, reduce the total thickness of the valve 10.

Fig. 5 shows a further arrangement in which the valve 10 acts as both an inlet and an exhaust valve. In this case the inlet apertures 26 are in the diaphragm 16 and the exhaust apertures are in a flange 35 on the housing 12. The inward movement of the movable member 18 during inhalation causes diaphragm 16 to occlude the outlet apertures 35 and to reveal the inlet apertures 26 allowing air to flow into the mask space 31. As the user exhales the movable member 18 is forced away from the mask space and the diaphragm 16 is rolled into a position in which the inlet apertures bear against the cylindrical wall 22 of the movable member and are thereby occluded. Simultaneously, apertures 33 in flange 35 are revealed and air can exhaust from the mask space to atmosphere therethrough.

Fig. 6 shows the pressure compensating valve 10 of Fig. 5 connected to a fan driven air blower 36 in a fan forced positive air pressure breathing apparatus. The fan 36 communicates with the valve 10 through a wide diameter hose 37.

Fig. 7 shows the pressure compensating valve 10 of Fig. 5 connected to an air supply such as a compressed air cylinder 38 or an industrial pressurised air supply (not shown) through a regulator 39. A narrow diameter high pressure hose 41 connects the air cylinder to the regulator 39 which is of conventional design. The regulator 39 is, in turn, connected to valve 10 through a wide diameter base 37.

Fig. 8 shows the pressure compensating valve 10 of Fig. 5 connected to an air supply such as a compressed air cylinder 38 through a regulator 39 in a self-contained breathing apparatus. In this case two narrow diameter hoses 42 and 43 connect the regulator 39 with the valve 10. The hose 42 acts as a pilot hose conveying to the regulator the pressure on the inlet side of valve 10.

Figure 9 shows an alternative embodiment of a pressure compensating valve according to the present invention. In this embodiment a tubular barrier means 50 is positioned between a pair of planar members 51 and 52. The barrier means 50 defines within its lumen a chamber adapted to receive high pressure air longitudinally of its length from an air supply (not

shown). The barrier means 50 and the planar members 51 and 52 are exposed on their left hand side to atmospheric pressure and on their right hand side to the pressure within an air outlet path such as a face mask.

When the pressures on the two sides of the barrier means 50 are equal the valve parts will be in the positions shown in Fig. 9(a). In this position an array of air inlet apertures 53 in the wall of the tubular barrier means 50 are obstructed by overlying the member 52. Similarly, an array of air outlet apertures 54 are obstructed because they overlie the barrier means 50.

If the pressure within the outlet path drops below that of the atmosphere the member 52 will be drawn relatively to the right to the position shown in Fig. 9(b). The arcuate walls of the barrier means 50 have now rolled relative to member 52 to expose the apertures 53 to the air outlet path. Air can flow into the outlet path in the direction of arrow A. Air will continue to flow until the pressure rises on the right hand side of the barrier 50 and member 52 to force the member 52 to move, relatively, to the left closing apertures 53.

If the pressure on the left hand side of the barrier 50 and member 52 exceeds that on their right hand side, the member 52 will be moved, relatively to the left. The barrier means 50 will roll, relative to the member 51, exposing the aperture 54 to the outlet path. Air can then flow in the direction of arrow B until the pressure in the outlet path drops to that of the atmosphere. At this time the member 52 will move, relatively, to the right and closing the outlet apertures 54.

It will be appreciated by persons skilled in the art that numerous variations and/or modifications may be made to the invention as shown in the specific embodiments without departing from the spirit or scope of the invention as broadly described. The present embodiments are, therefore, to be considered in all respects as illustrative and not restrictive.

Dated this eighteenth day of February 1997

SAFETY EQUIPMENT AUSTRALIA
PTY LTD
Patent Attorneys for the Applicant:

F.B. RICE & CO.

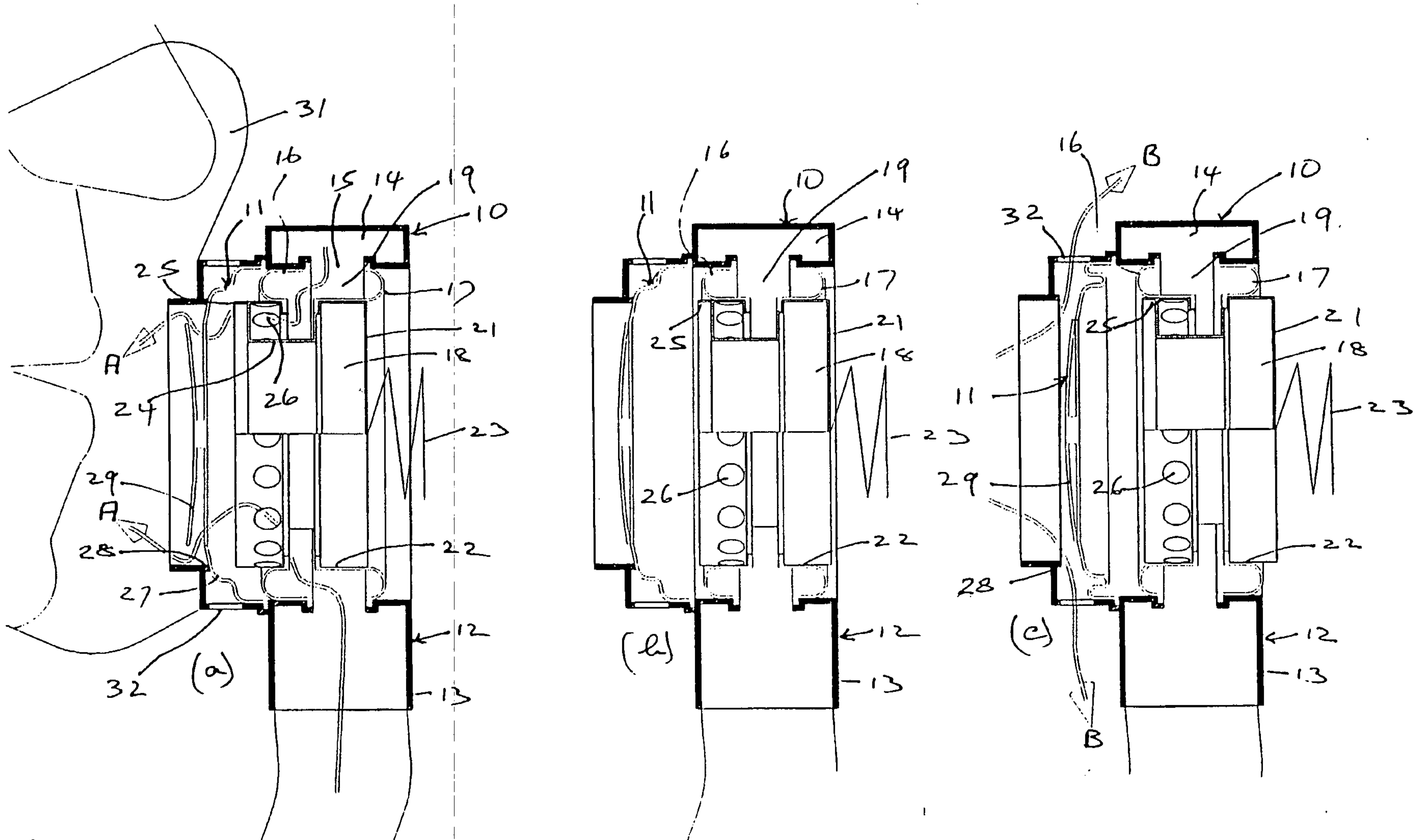
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FIG 1

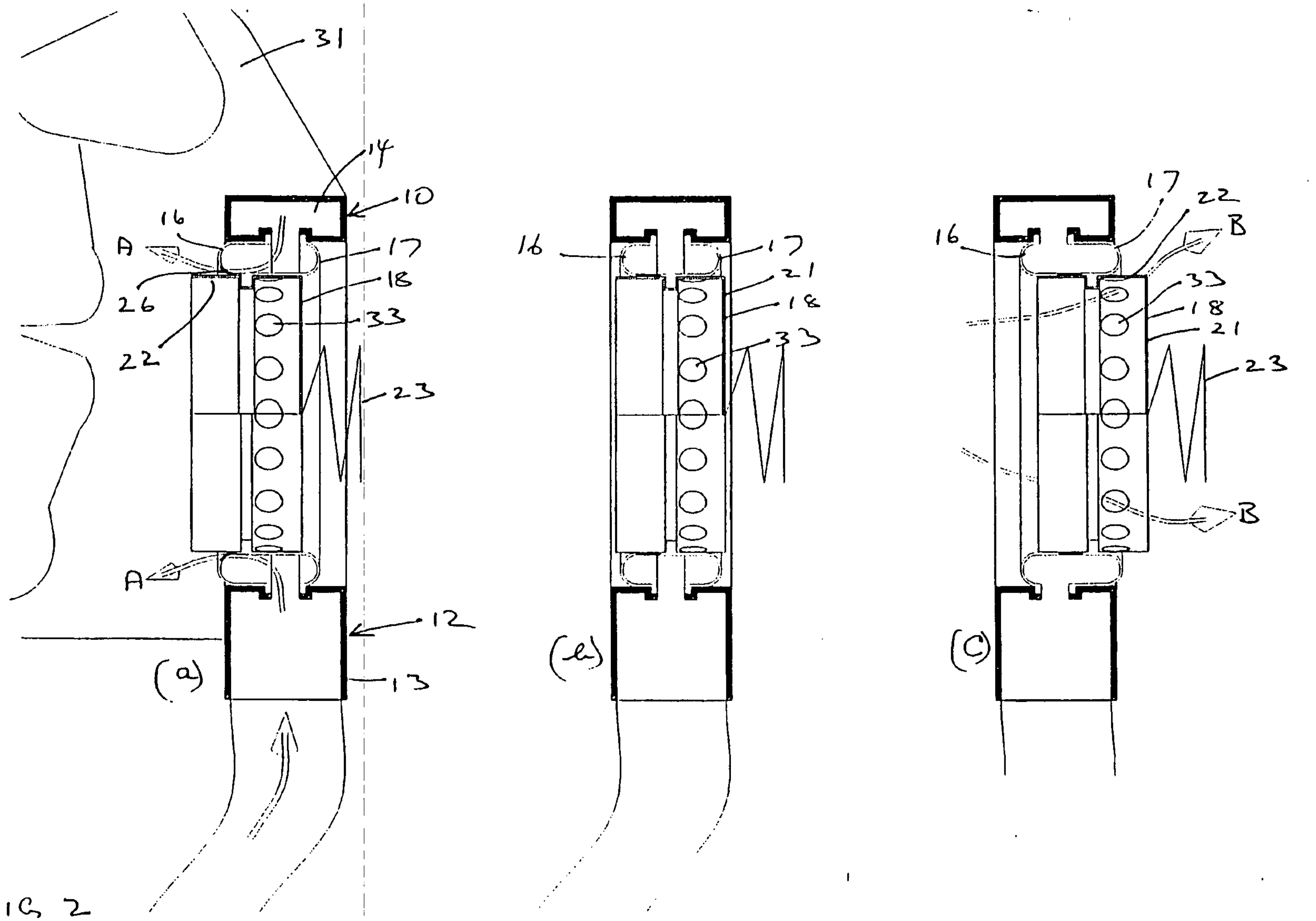

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FIG 2

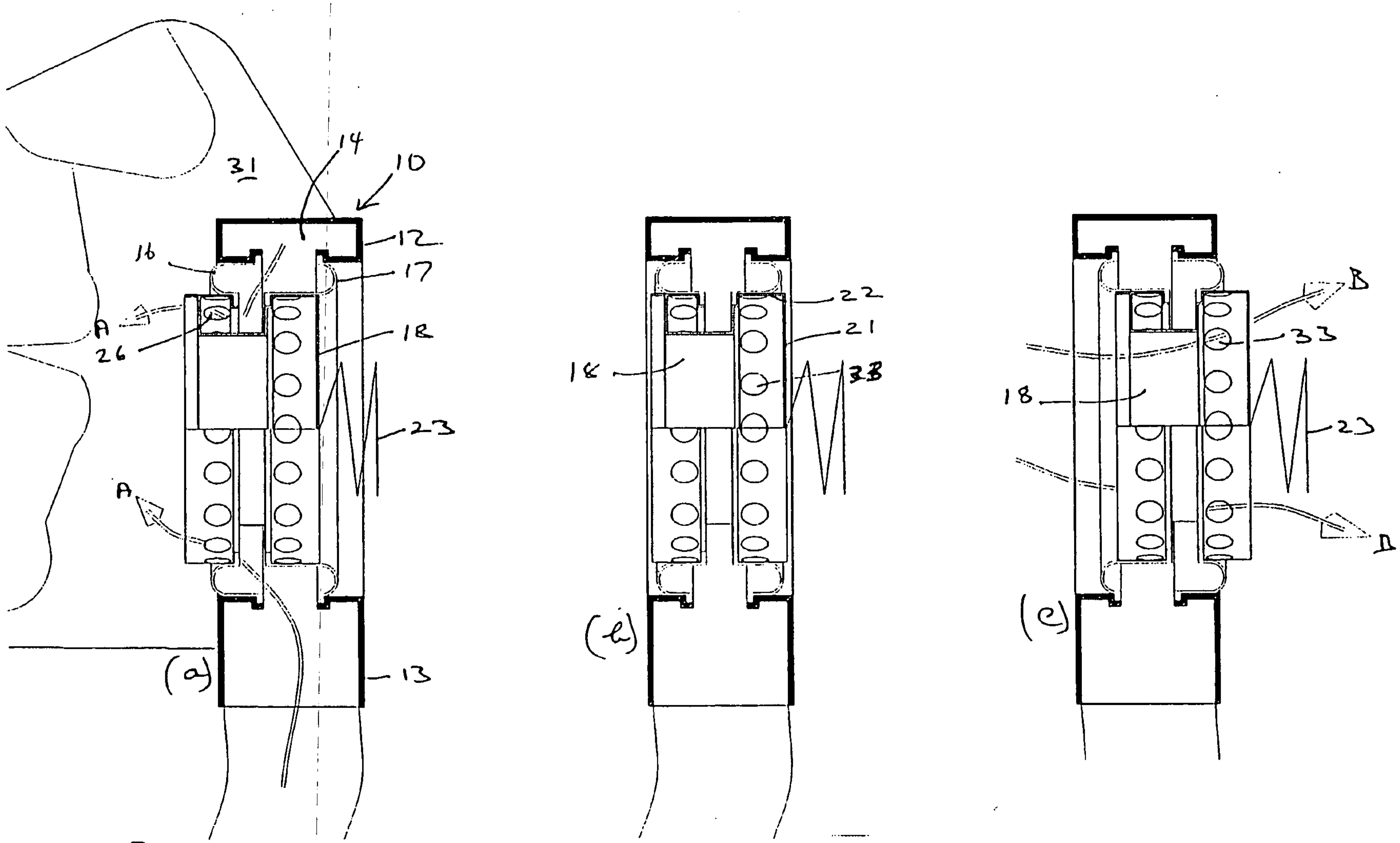


FIG 3

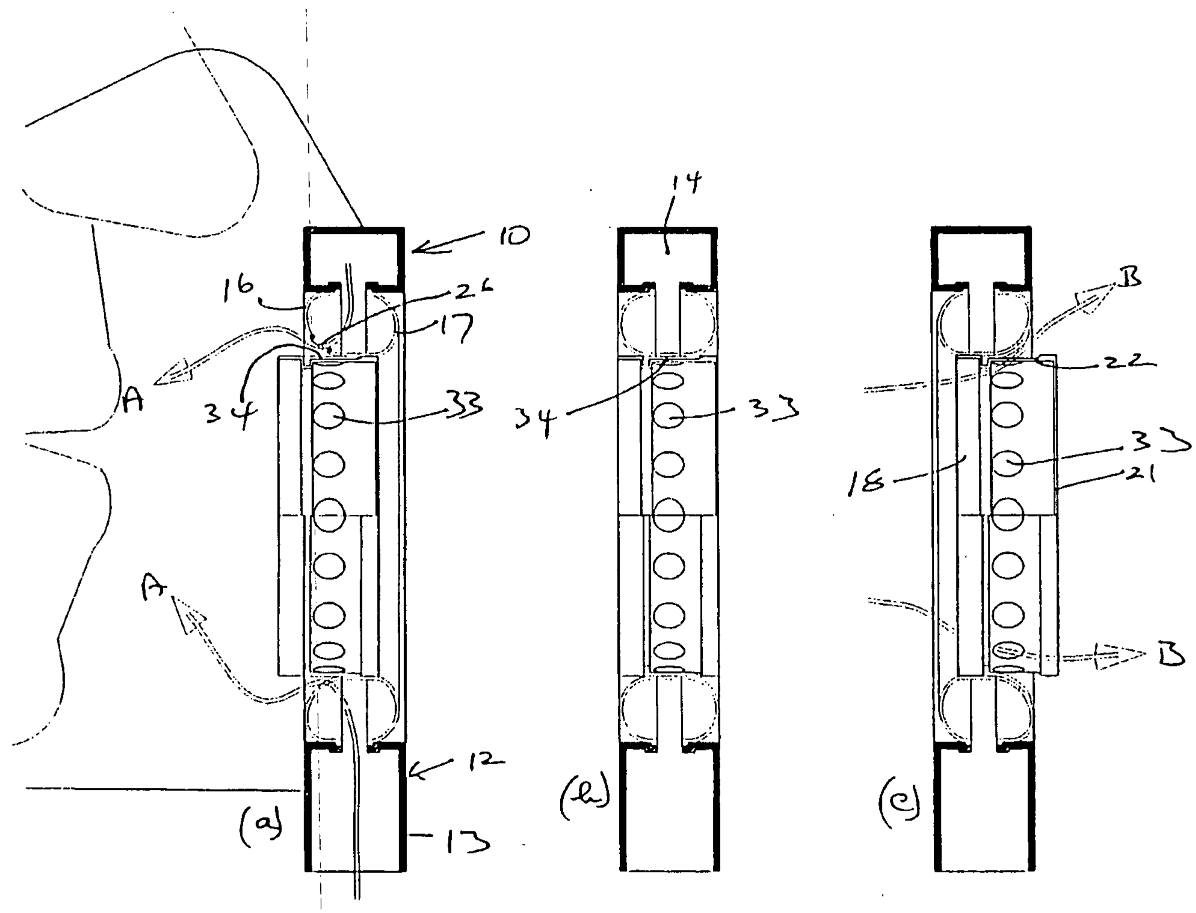


FIG 4

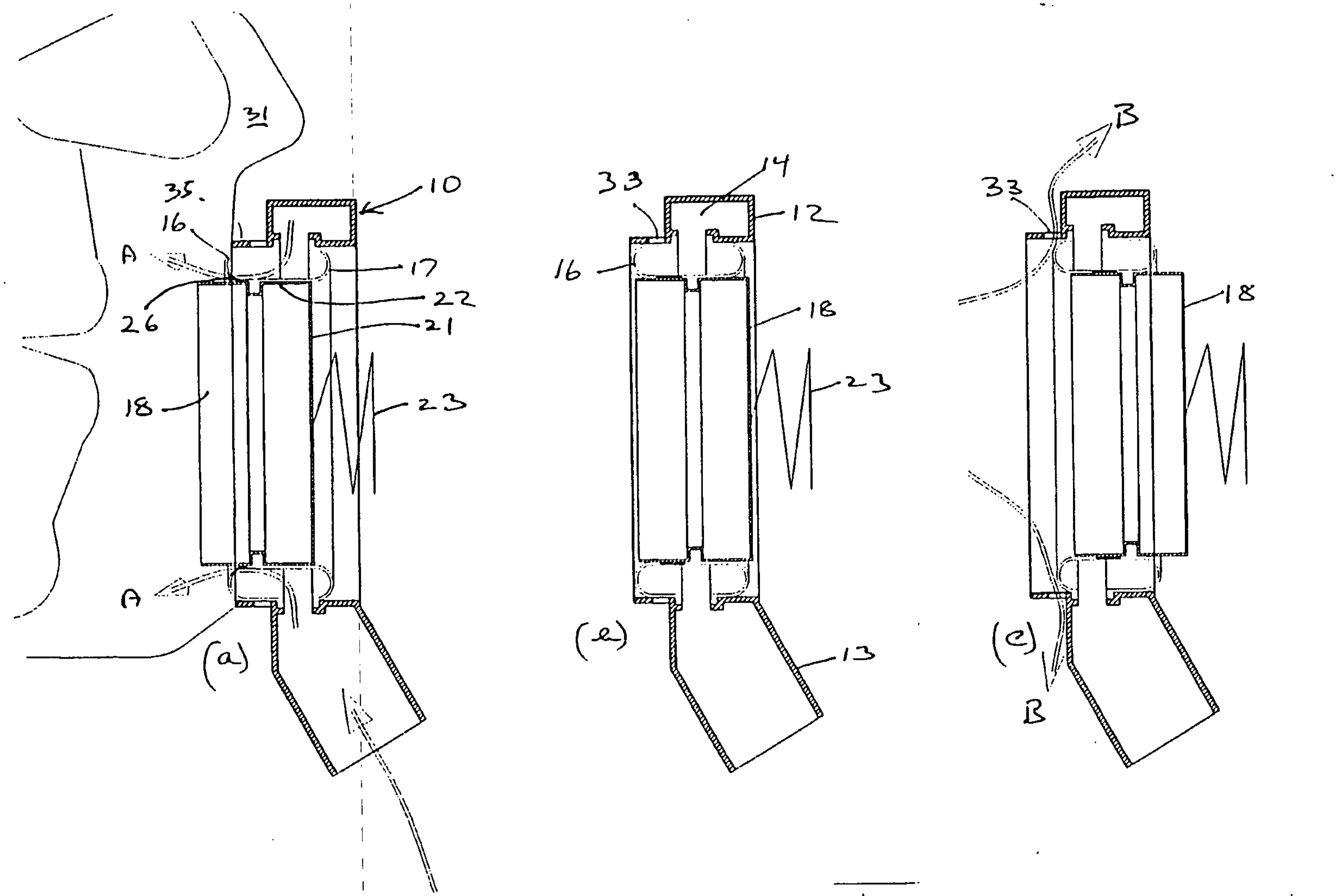


FIG. 5

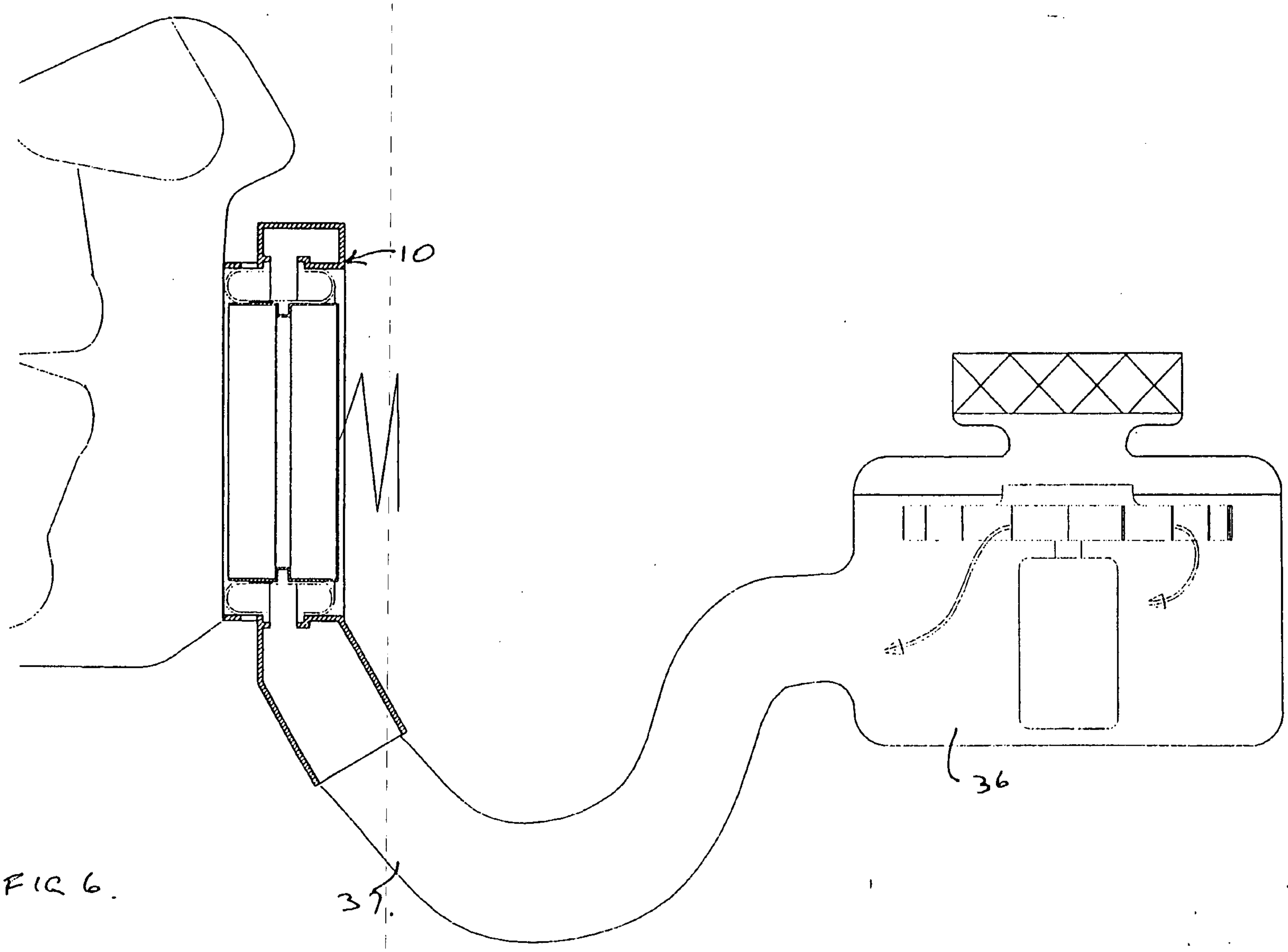


FIG 6.

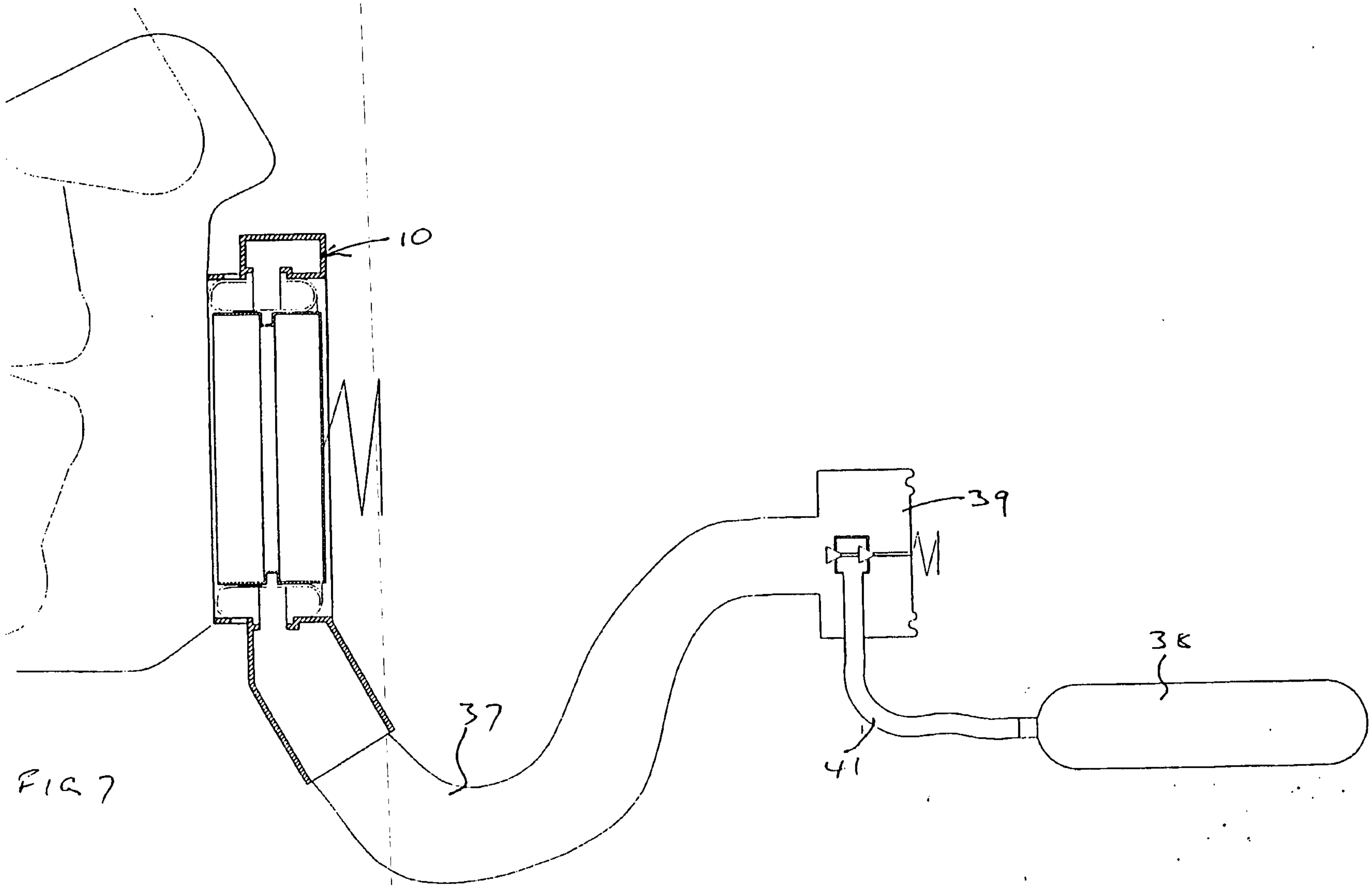


FIG 7

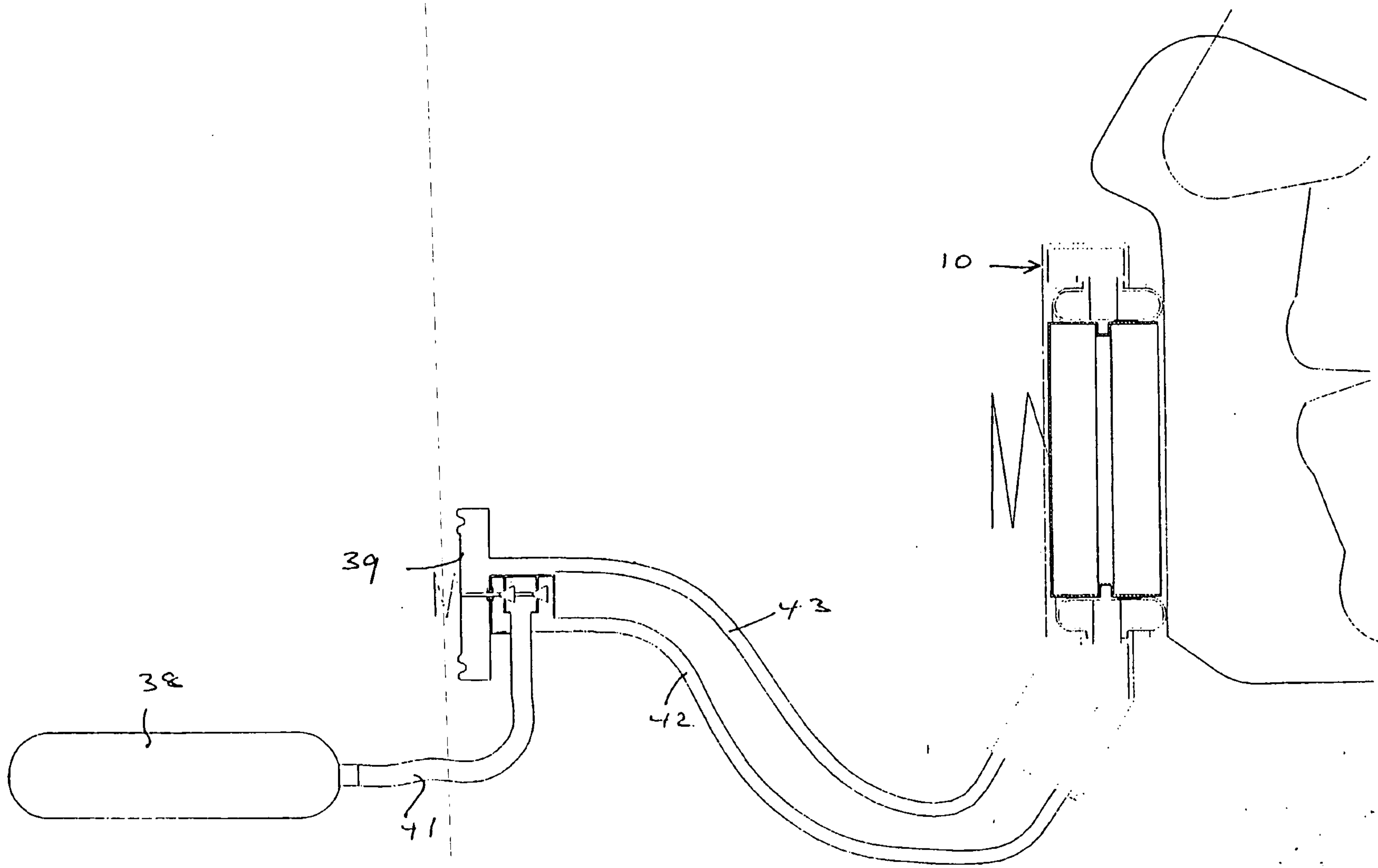
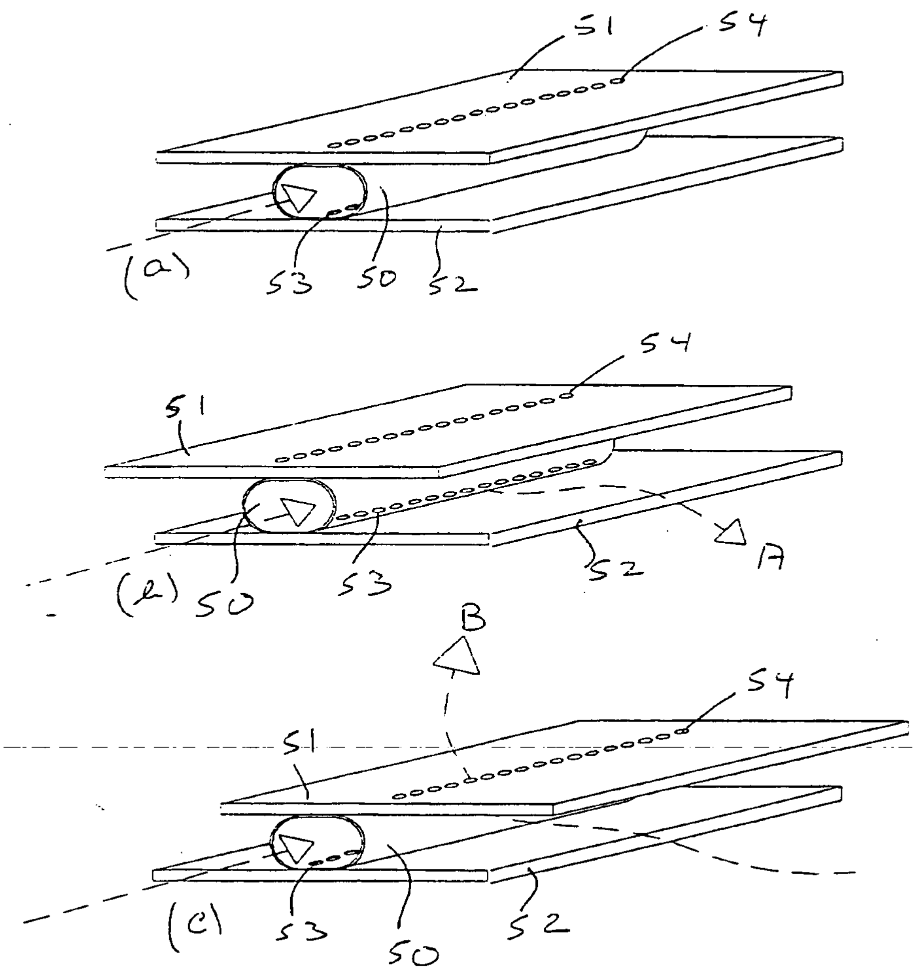


FIG 8

FIG. 9



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